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Objectives of a 2-volume book developed as a comprehensive reference for teachers and a text for students on small gasoline engines were that it be: (1) organized for teaching, (2) complete in detail, (3) well illustrated, (4) authentic, (5) edited to high school reading level, (6) correlated with basic scientific principles, and (7) evaluated by experts and through actual teaching experience before being published. Evaluation of the preliminary draft by 22 teachers under actual classroom and laboratory conditions revealed: (1) Operating and scientific principles were easy to understand, (2) Adequate information was given to explain each subject, (3) Few errors were found in the subject matter, (4) The illustrations were clear and understandable and added clarity, (5) The lists of tools were adequate, (6) Students completed jobs from the instructions given without teacher assistance, (7) Teacher preparation time was reduced by 20 percent, (8) Student learning speed was increased by at least 17 percent, (9) The students' average grades were 10 to 12 percent higher, and (10) Each student needed a copy of the text for efficient learning. The volumes, published in four colors in sufficient quantity for national and international distribution, are available as VT 006 206 and VT 006 290. (DM)

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FINAL REPORT

DEC 9 1968

Development of a Teaching Text on...

CARE, OPERATION, MAINTENANCE, AND REPAIR OF

AIR-COOLED GASOLINE ENGINES

OFFICE OF EDUCATION
Grant Number OEG-2-6-000484-0285

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Development of a Teaching Text

on

CARE, OPERATION, MAINTENANCE AND REPAIR OF

AIR-COOLED GASOLINE ENGINES

By

Howard Turner, Principle Investigator

Office of Education
Grant Number OEG-2-6-000484-0285
The Vocational Education Act
of 1963, P.L. 88-210 Section 4 (c)

The University of Georgia
and the
American Association for Agricultural Engineering and Vocational Agriculture
Agricultural Engineering Center
Athens, Georgia 30601

August 1968

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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SUMMARY OF PROJECT

Grant Number: OEG-2-6-000484-0285

Title: Care, Operation, Maintenance and Repair of Air-Cooled Gasoline Engines
(A Teaching Text)

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Grantee Institution: The University of Georgia
Athens, Georgia 30601

Duration: June 1, 1966 - May 31, 1968

Objectives:

To develop a teaching text on the subject of small gasoline engines that is:

- organized for teaching.
- complete in detail, explaining "why" as well as "how".
- well illustrated.
- authenic -- documented with research and supported by field experience.
- edited to high-school reading level.
- correlated with basic scientific principles so a student may relate them to his science training.
- evaluated by experts and through actual teaching experience before being published.

Procedures:

An outline was prepared which was declared adequate by the cooperating states to meet the scope of the subject.

Information was procured from all known sources -- industry, libraries, experiment stations, colleges, state departments of education, trade associations, publishers and individuals.

The information was organized, edited and illustrated into a teaching type of publication and issued first in the form of a preliminary draft. The preliminary draft was evaluated as follows:

> Twenty-two teachers in three states were given copies of the preliminary draft from which they taught subjects of their own choosing and evaluated the adequacy of the text.
>
> One hundred seventy-one copies of the preliminary draft were sent to experts in small-engine manufacturing, service and repair and to interested educators. Their suggestions were incorporated in the final edit.
>
> Step-by-step maintenance and repair procedures given in the preliminary draft were checked by two agricultural-engineering graduate students on two different types of small engines.
>
> One repairman, with many years of experience in the service and repair of small engines, was engaged to review the book.

All suggestions were incorporated into a final manuscript which was edited to high-school reading level, and illustrated in color to accent points of emphasis.

A well-known grammarian was engaged to correct the final manuscript for composition and grammar.

Twenty thousand copies of the final draft were printed in four colors for national and international distribution.

Results and Conclusions:

This project has resulted in what we believe is the most complete teaching text now available on the subject of small engines. We believe it adequately meets the objectives set forth in the project.

The 2-volume book is both a comprehensive reference for teachers and a text for students. Since the book is a summary of 403 references, little or no additional reference material is required for teaching except operators' manuals and service manuals for specific engines.

For convenience, it was published in two separate volumes. Volume I consists of 158 pages with 294 illustrations. It deals primarily with operating principles, care, operation and simple day-to-day maintenance of 2-cycle and 4-cycle engines. Volume II consists of 212 pages with 567 illustrations. It deals primarily with major maintenance and repair. It explains the operating principles of different units, how to tell when they are not working properly and how to repair them.

Both volumes are 8 1/2" x 11" and the illustrations are in four colors. Color is used for accent and retentiveness -- not just for attractiveness. Each volume is cross-referenced with the other so as to closely correlate the subject matter. Each may be used as a separate text, but for complete subject coverage both volumes are necessary.

Each volume is indexed for quick reference.

Evaluation by teachers who used the preliminary draft under actual classroom and laboratory conditions was both gratifying and revealing. In general, they agreed to the following:

- Operating and scientific principles were easy to understand. No additional explanation of principles was needed.

- Adequate information was given to explain each subject.

- Few errors were found in the subject-matter.

- The illustrations were clear and understandable, and of sufficient number for easy comprehension.

- The illustrations added more than 21% to the clarity of the subject-matter.

- The lists of tools were adequate for doing the jobs.

- Students completed the jobs from the instructions given in the preliminary draft without assistance from the teacher.

- The teachers estimated that their lesson preparation time was reduced by at least 20% as compared to using other teaching references.

- The teachers estimated that their students' learning speed was increased by an average of at least 17%.

- The students' average grades were 10% to 12% higher than grades from students who were previously taught the course without the use of this text.

- Each person studying small engines should have a copy of the text for efficient learning.

To develop an adequate teaching text on small engines requires the services of a staff specialized in the field of subject-matter preparation, who is also knowledgeable in the area of small engines, plus the whole hearted cooperation of teachers, teacher trainers, engineers, manufacturers, service

men and others. Special competence is also required to convert visual concepts into finished illustrations where color can be used effectively as an aid to training.

An author working on his own -- without these special talents and extensive cooperation -- would find the task impractical if not impossible.

As a result of the development of this project, the first comprehensive text on the subject of small engines was made available to teachers and students. The text offers two primary advantages. It saves teachers time in lesson preparation, and it increases the learning speed of students.

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I. PROBLEM

Within the last decade small, air-cooled, high-speed, lightweight gasoline engines have gained wide acceptance. They have filled a very great need for small power units where electric motors cannot be used to advantage, such as on lawn mowers, chain saws, small electric generating units, transport refrigeration units and small tractors.

The principles of operation are much the same as the early types of gasoline engines, but the general design is decidedly different. In fact, there are many varieties of designs. They are widely used for farm, commercial, industrial and suburban purposes, yet most users know little more than how to start and stop them and how to refuel them.

At the present time, there are millions of these engines in use and millions of operators trying to make them perform satisfactorily. At least 15 different manufacturers produce an average of six different models each year. Each model may have several adaptations for specific jobs. Service shops are woefully short of trained mechanics to service the engines. As a result, courses in small engine care and operation, maintenance and repair have become quite popular as part of high school training and for adult classes. Teachers also recognize that a study of small engines does a good job of preparing students for courses in tractor and automobile operation and maintenance.

Prior to the completion of this project, the problem facing teachers was the lack of adequate, well organized teaching information. Here was the situation with regard to the subject of small engines:

1. There was <u>no publication available which supplied adequate and complete facts</u> for a teacher to do a good job of teaching.

   There are many references (more than 400) in the form of service manuals, sales literature and popular articles, but a disproportionate amount of time is required to glean the few and inadequate facts they contain. There are a few books available, but the information is focused on certain specialized areas.

2. <u>Research references are often not readily available to teachers</u>.

   When they are, there is still a question of interpretation. Examples of these are research studies of manufacturers which have not been published, or are published on a limited scale for circulation within the industry.

3. The materials are not organized for teaching.

   Generally manufacturers' information applies to only their make of engines and sometimes to only one model of their make.

4. Some of the information is too technical for a teacher or student to understand readily.

5. The explanation of basic principles in available literature is not adequate.

6. Some of the information is too general to be factual.

7. Nomenclature varies for the same unit.

   The same parts on different makes of engines may be called by several different names. This makes teaching difficult for the instructor and also difficult for the student. Properly prepared teaching material recognizes the different terms used for a specific product.

8. Much of the literature assumes that the reader already has a good background of information.

   This assumption, at this stage of training, is certain to be in error with most trainees and many teachers.

9. Illustrations are often omitted or are inadequate.

10. Few teachers have the time to review all the references needed, and then prepare adequately for effective teaching.

II. OBJECTIVES

According to a report from Encyclopedia for Educational Research, 1960, "Textbooks are too hard for the students who use them." The report further states that many textbooks are inadequate and fail to develop the objectives for which they are written.

It was the purpose of this project to show how a text could be prepared which would meet the objectives of providing both an adequate reference for teachers and a complete text for students.

Objectives at the outset were to provide adequate facts in an illustrated text on the subject of 2-stroke cycle and 4-stroke cycle air-cooled engines and to present them in an orderly, simplified, easy-to-understand manner, so the subject would be easy to teach and easy to study even for those students wishing to learn on their own time.

The information would be documented whenever possible.

Scientific principles were to be discussed in a manner that would enable them to be transferred to other engine designs and also to other classes of engines such as those in tractors and automobiles.

With information documented and prepared in this manner, it would be relatively easy to develop the subject for lower grade levels than high school, if needed, or to prepare more technical publications above high school level when desired.

III. PREPARATION OF THE PRELIMINARY DRAFT

A tentative outline was prepared and copies were mailed to approximately fifty teacher trainers and agricultural engineers at colleges throughout the United States. Their suggestions and criticisms were incorporated into a working outline.

Information was assembled from industry, scientific publications, engineering experiment stations and others. Four hundred and three (403) references were numbered, recorded and filed under categories of (1) engines, (2) parts and accessories, (3) tools and equipment, (4) commercial publications, (5) public education, (6) textbooks, (7) equipment powered by small engines, (8) research materials, (9) safety, and (10) fuels and lubricants. Each document was given a code number for easy reference.

Special information was acquired on the service and repair of both 2-cycle and 4-cycle engines. A 2-cycle engine school was attended by the author. It was a 3-day school designed for teachers of agriculture. A 5-day school was attended by the author at the Briggs and Stratton factory in Milwaukee, Wisconsin. It was a special training course for teachers in the service and repair of small engines.

A questionnaire consisting of 42 technical questions was prepared and given to seven different engine manufacturers for answers. The information requested was from normally unpublished data available only from their engineers. A sample of the questionnaire is in Appendix A, page 23.

Visits were made to eight small-engine manufacturers for the purpose of getting acquainted with their service managers and instructional personnel. All manufacturers were very receptive to the project and were in agreement that their business improves as the public gains a better knowledge of their product. Manufacturers visited were as follows:

Wisconsin Engine Corporation

Briggs and Stratton Manufacturing Company

Jacobsen Manufacturing Company

Clinton Engines Corporation

Beaird-Polan Inc.

Tecumseh Engine Products

Lawn Boy Manufacturing Company

West Bend

All manufacturers visited, except Beaird-Poulan, supplied an engine which was used for study and checking of procedures and for photographing. In addition to those listed, the McCulloch Corporation supplied a chain saw.

With the information received from the various sources, a working file was established. It consisted of folders set up and labeled in order of the outline. Pertinent information was taken from the references and filed under each outline heading.

Upon completion of the file, this material was screened and organized in logical sequence for the preparation of the first draft, each section being developed at a time. It was then dictated for typing.

At the same time the manuscript was being prepared, illustrations were developed to support the text. Wherever an illustration was needed to clarify a point, it was clipped from a reference or sketched. Specific instructions were dictated for the art director to follow in further developing the illustrations. A caption, explaining the illustration, was also prepared.

The "Problem Approach" method was used in developing the text. Each problem was dealt with according to the proper sequence for (1) recognizing there is trouble, (2) locating the trouble, (3) correcting the trouble. (It is believed that a book prepared in this manner will be more useful than one developed on the basis of merely taking the engine apart, looking at the parts and putting them all back together).

The first draft was then re-edited. The text was checked for clarity, sentence structure, paragraph development, continuity, spelling, punctuation, emphasis and accuracy. At the same time new facts were added which were uncovered from the latest reference material received. References to illustrations, to headings and to numbered references were also checked.

Illustrations were completed and checked for clarity, emphasis, understanding, simplicity, accent, labels, captions and accuracy.

A second draft was then typed -- column width -- for the purpose of pasting up along with illustrations for reproduction.

Camera-ready pages were prepared from which a preliminary draft was printed.

Five hundred copies of the preliminary draft were reproduced for review and evaluation.

IV. PROCEDURES FOR EVALUATING THE PRELIMINARY DRAFT AND RESULTS

A. Evaluation from Actual Classroom Teaching and Laboratory Use

Nine teachers of vocational education in Georgia and South Carolina were visited and each given enough copies of the preliminary draft for themselves and each student in their respective classes. Each teacher was asked to select two subjects from the book and teach them. Two questionnaires (one for each two subjects taught) were given each teacher for reporting his findings after using the book under actual classroom and laboratory conditions.

Seven teachers reported on two subjects while two teachers reported on only one subject each, thus (statistically) a total of 16 teachers reported from Georgia and South Carolina.

A copy of the questionnaire is included in the Appendix B, page 29.

At the request of Dr. Robert Price, Head of the Agriculture Education Department at Oklahoma State University, a supply of the preliminary drafts were provided for study by six teachers in that state. They were used by Gene Dewitt in partial fulfillment of the requirements for a Master of Science Degree.* Information from that study is also included in the tables to show how closely the results parallel those from Georgia and South Carolina.

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*An Analysis of the Effectiveness of the Use of a Preliminary Draft of a Reference Text on Small Engines as Taught in Six Vocational Agriculture Departments; Dewitt, Gene, Oklahoma State University, Stillwater, Oklahoma, July, 1968.

TABLE I. TEACHERS' BACKGROUND AND THE CLASS SITUATION

	GA. and S.C. (16 Teachers)	OKLAHOMA (6 Teachers)
Teachers' Background		
1. Teaching experience in Voc. Ag. (av.)	12.5 yrs.	10.8 yrs.
2. Previous training in small engines (av.)		
High school	3.3 wks.	10 wks.
College	4.9 wks.	0
Short Courses	5.5 wks.	7 wks.
3. Teaching experience in small engines (av.)	0.5 yrs.	3.2 yrs.
4. Short courses previously taught to young and adult farmers (av.)	2.4	0
5. Practical experience in the care and repair of small engines (av.)	7.5 yrs.	3.1 yrs.
Class Situation		
1. Grades taught in this evaluation	11-12	11-12
2. Ages of students	16-18 yrs.	16-18 yrs.
3. Average number of students in each class	18.8	14.0

TABLE II. TEACHERS' USE AND APPRAISAL OF THE SMALL ENGINES PUBLICATION (Preliminary Draft)

	GA. and S.C. (16 Teachers)	OKLAHOMA (6 Teachers)
Teachers' Use of the Preliminary Draft		
1. Number of references previously used (av.)	2	3
2. Number of additional references used with this draft (av.)	0.75	1
3. Teachers making home study assignments (av.)	56%	0
4. Teachers making classroom assignments (av.)	44%	100%
5. Teachers who changed their teaching procedures	44%	33%
6. Teachers changing organization of the draft	12%	0
Teachers' Appraisal of the Preliminary Draft		
1. Teachers agreeing that all principles were easy to understand	94%	100%
2. Teachers who felt there was enough information	81%	100%
3. Teachers who felt there was too much information	12%	0
4. Number of teachers finding errors	6%	2%
5. Teachers agreeing that enough illustrations were included	81%	100%
6. Teachers agreeing that the illustrations added clarity	100%	100%
7. Degree to which clarity was improved by illustrations (av.)	21.2%	20%
8. Teachers agreeing that all illustrations were clear	81%	100%
9. Teachers having difficulty finding illustrations.	0	17%
10. Teachers agreeing that tool lists were adequate	90%	100%
11. Students understanding principles in text without additional information	70%	100%

TABLE II. (Con't.)	GA. and S.C. (16 Teachers)	OKLAHOMA (6 Teachers)
12. Classes needing no assistance other than the preliminary draft.	95%	100%
13. Estimated time saved by teachers in preparation of lesson plan	20%	13%
14. Estimated increase in learning speed. . . .	17%	12%
15. Estimated increase in average grades over previous classes	12%	10%
General Recommendations		
1. Teachers recommending filmstrip paralleling the text	94%	100%
2. Teachers recommending overhead transparencies from illustrations in books	94%	100%
3. Teachers recommending the use of color in the final publication	17%	12%
4. Teachers recommending that the final publication be printed in one volume	62%	100%
5. Teachers recommending that each student have a copy of the text	100%	100%

B. Individual Review

Of the 171 copies of the preliminary draft which were sent to individuals for review, 60 were returned with comments marked on the draft itself. An additional 60 persons wrote letters giving their suggestions and comments. The remaining 51 had no suggestions. The number of suggestions per returned copy ranged from none to more than 100. Excerpts from some of the letters received are shown in Appendix C, page 37. These excerpts give examples of the types of criticisms and comments which were received. They also reveal the wide range of interests and authority of the reviewers. A total of 1723 suggestions came from all sources.

Many of the reviewers dealt only with subjects in their particular field of interest. For example, a spark-plug manufacturer reviewed only that part which covered spark plugs. The American Battery Association reviewed the section on batteries only. Piston-and-ring manufacturers reviewed the sections on pistons and rings. Therefore, each section was reviewed by specialists in their field. This type of review gives the final book the advantage of each subject having been reviewed by 80 experts who were able to recognize errors which are not generally recognized. Points of controversy were clarified and the authenticity of the book is greatly increased.

Complete cooperation was received from all manufacturers of engines and engine parts and tools. Each one gave the information requested and offered suggestions to improve the book.

Educators were quick to recognize the potential of such a book and readily gave their time and professional advice. Eighty-one educators suggested changes for increasing the effectiveness of the book as a text and a teaching reference.

All suggestions were studied and given proper consideration for inclusion in the final draft of the book. How this was done is discussed under "Preparation of the Final Draft," page 17.

C. Laboratory Testing

The accuracy and sequence of the procedures given in the preliminary draft for doing the service and repair jobs were tested on two different engines -- one a 2-cycle engine and the other a 4-cycle engine.

Two graduate students in the Department of Agricultural Engineering at the University of Georgia were engaged to perform the tests. The two engines had been used and both were in need of maintenance and repair.

A laboratory was assigned to the students and all the necessary tools, parts, and materials were provided.

Starting at the beginning of the preliminary draft, they followed the procedures for doing each job. As they performed the jobs they made notes of irregularities in procedures, and made suggestions for clarifying points, rearrangement of steps and the need for additional information.

Although this test was made on only two different engines, it revealed unexpected difficulties, and need for additional tools and equipment. Such information was added to the final draft.

D. Review by Experienced Mechanic

A local mechanic -- Assistant Superintendent at the Athens, (Georgia) Country Club, who is well-known for his experience and ability in the repair of small engines -- was asked to review the preliminary draft in the presence of the author.

Many practical suggestions came as a result of this review. Procedures and techniques that come only from experience in working with engines were revealed. Discrepancies in the draft, which might have otherwise gone overlooked, were pointed out by this method of review.

The author was able to ask questions, the answer to which had not been found in the printed reference materials.

The benefits of this review were included in the final draft.

V. PREPARATION OF THE FINAL DRAFT

A. Preparation of the Final Manuscript

The first step in the preparation of the final manuscript was to prepare an extended-margin copy of the preliminary draft and record on the margins the suggestions and criticisms received from the various sources. The extended-margin copy was prepared by taping an 8 1/2 x 11-inch sheet to the edge of each page of one copy of the preliminary draft.

Each reviewer was given a reference number as his report was received. This number was placed on the preliminary draft he returned or on his letter. Each suggestion was recorded on the extended-margin along with the reference number of the reviewer. Then the reference number was inserted on the printed page of the preliminary draft of the location where the suggestion applied.

The second step was to edit each paragraph and each illustration for technical accuracy, and to make certain the information was in the proper sequence for final typing.

The final manuscript was re-edited for simplicity, clarity and completeness by both the principal investigator and the program director. Since most students of small engines are of high-school age or high-school reading-level intelligence, the text was edited for high-school reading level. The Flesch system was used.

It was also edited for composition and grammar by an experienced grammarian. A retired high school teacher of English and literature was engaged to review both the preliminary draft and the final manuscript. Although she did not change the format and structure of the book, she pointed out many areas for improvement in use of words. She checked spelling, punctuation and sentence structure.

It was then submitted to the printer for preparation of column-width galley proofs. These were proofread and corrected. A "dummy" layout was prepared to guide the printer in setting up the page proofs.

B. Preparation of the Final Art Work

Special instructions for final development, labeling, and color for each illustration was dictated, typed and attached to the separate card on which each illustration was mounted. The original illustration -- clipped from the preliminary draft -- was pasted on the card. If there were new photographs and sketches, cards were included for them. This information was for the art director.

At the same time lists were made as to which photographs would be ordered from various manufacturers, which ones would be sketched, and which ones would be photographed by the author.

In addition, one copy of the preliminary draft was colored by the author to point out the major points of emphasis. This color copy was given to the art director as a guide for preparing the color separations on the final art work.

The art director prepared the art work for the printer from the materials and instructions suggested by the author. The materials consisted of original art work from manufacturers, original photographs from manufacturers, photographs taken by the author, art work clipped from manuals, sketches prepared by the author and from engine parts from which the artist made sketches directly.

The art work was either pasted to, or drawn on, illustration board and touched up according to the author's instructions.

An automatic camera was used to standardize the size of each illustration. It was also used to size the labels to fit various illustration sizes and fit the spaces in the dummy layout.

Arrows were inserted from the labels to the corresponding parts. Color overlays were placed over each illustration and the part for emphasis was masked for color. Instructions to the printer were stamped on each card. A protective cover of transparent paper was placed over each illustration which was used by the author for making suggestions and adjustments.

When completed, the art work was submitted to the printer along with the "repro-page-proofs" and the dummy layout for printing.

C. Preparation for Reproduction

No matter how carefully the manuscript is prepared and edited, and how well the illustrations are developed, it is still important to follow through very carefully with the printer to get the finished product desired. Consequently, all linotype work, in preparation for the final reproduction, was done by the University Print Shop. In this way full control of the type face selected was had -- also the use of special type (italics, boldface, etc.). Therefore all necessary proofing could be done before the publication was submitted for bids.

The galley proofs prepared from the typed manuscript, were edited and corrected.

The galley proofs were also used to prepare a dummy layout for the final publication which is a second major factor in quality control. This enabled us to coordinate the location of illustrations with the text. In many cases the illustrations had to be increased or decreased in size to meet the various space conditions. In other cases the spacing between lines of type had to be altered.

With all editing completed and necessary provisions made for proper spacing of text and illustrations, repro-proofs (camera-ready) pages were made and provided to the publisher.

The table of contents and index were prepared from the page proofs. Bids were requested from several printers and the printer submitting the lowest bid was awarded the contract.

A final "color cote" proof which is an almost exact replica of the final book was prepared by the printer. It included all of the illustrations in color along with the text. This proof was read and approved by both the author and the art director before the final printing of the book.

VI. CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

In addition to the discussion under "Results and Conclusions", page 2, there are several other factors that need further consideration.

We feel it is significant that in the evaluation study, the 22 teachers reporting used only 2 to 3 references -- on an average -- per teacher in their previous teaching program. This confirms our previous observations on other subjects. We know too that many of these references are obsolete, or limited to the product made by one manufacturer, or both. In contrast 403 references were used in the preparation of the Small Engines text included with this report. The new text will fit the teachers' present practice of using limited references yet give them the advantage of the 403 references used in developing the two volumes on small engines.

If a text of this type had not been prepared, there is a strong possibility that teachers would either become less effective as new knowledge outpaces their ability to keep up or, they would become so overwhelmed they would discontinue teaching the subject.

Occasionally, the comment is made that the contents of a publication should be limited to information the teacher will have time to teach in the time allotted on his schedule. The evaluation reveals that only 2 of 22 teachers felt that the information was too complete even though it is far more than a teacher is likely to cover in class sessions. This also supports previous checks we have made from time to time. A teacher would rather have complete information in one text so as to (1) provide a wide choice of lesson options rather than be arbitrarily limited to a predetermined area, and (2) provide a source of knowledge in areas where he feels less competent.

Ease of revision is a factor that can be overlooked in the preparation of a text. If the research has been exhaustive in the initial preparation, as it has been in this case, research for the revision can be limited to those references issued since the date of the initial publication.

This book has a broad application. Because of the level on which the book is written and the breadth of subject matter coverage, this text can be used in other phases of training besides vocational agriculture, for example: industrial arts, trades and industry, factory schools for mechanics, adult classes and individual self-training.

It is recommended that consideration be given to two types of studies to serve as a guide in subsequent subject-matter development:

1. A study of the economic effects in such terms as: (a) preparation time saved by a teacher when using comprehensive text material designed for teaching, and (b) the learning time saved by a student who studies the text. There is some evidence that texts of this type lend themselves to self study thus saving both the student's and teacher's time.

2. A study of the fundamentals in text development that contribute to rapid comprehension, such as: use of the problem approach; use of color; extensive use of illustrations; editing to a predetermined reading level; use of italics and boldface lettering, weighted headings, etc., for accent; and discussions that explain "why" as well as "how". At present, authors have little to guide them in the preparation of an effective text.

VII. APPENDICES

APPENDIX A

QUESTIONS ON SMALL GASOLINE ENGINES
(Directed to Manufacturers)

Questions on Small Gasoline Engines

AAAE & VA Ag. Eng. Dept.
University of Georgia
Athens, Georgia

1. What is a logical sequence for trouble shooting?

2. Name common tools and equipment needed for maintenance and repair.

3. Name special tools and equipment needed for maintenance and repair.

4. What is the difficulty of using the wrong octane gasoline?

5. Why use paraffin base oils in 2-cycle engines? How would a user know when he has a paraffin base oil?

6. What are the chief maintenance problems with small engines?

8. How can educational institutions help?

9. Do you have a simple dynamometer suitable for classroom use?

10. Do you recommend compression tests for engine diagnosis?

11. Is there a breaking-in period? What?

12. What teaching aids are needed?

13. Name sources of research information.

14. Do you have nay test results concerning operation and maintenance?

15. How much maintenance should the owner attempt to do?

16. Do you have any special instructions for safety?

17. Do you have demonstrational units: Cutaways, Engines, Charts, Slides, etc? How can they be acquired?

18. Who is our contact man for information with your company?

19. What compression ratio do you try to attain with your engines?

20. What design characteristics add more horsepower? More torque?

21. What octane rating gasoline do you recommend? Is there a correlation with compression ratios and octane ratings needed?

22. What quality oil do you recommend? MS? MM? ML? Why? Why not use detergent oils?

23. Many oil companies claim there is no practical disadvantage to using leaded gasolines for small engines. Do you agree? Do you have experimental evidence to show any practical disadvantages?

24. Some operators' manuals recommend draining gasoline for winter storage and filling with a rust preventive oil. I know of no one that does it. Are there tangible advantages that justify this recommendation?

25. What are the design factors in the spark plug used in small engines?

26. Does the industry have horsepower limits it considers maximum for "small engines"?

27. What critical angles of incidence are there beyond which a carburetor does not work satisfactorily?

28. Are there any studies on the efficiencies of the different air cleaners used on small engines?

29. How long can an engine be expected to last without any air cleaner? In clean air? In dirty condition?

30. How fast does the efficiency of an engine reduce as the air cleaner clogs?

31. Are small engines designed with any specific number of running hours in mind, assuming favorable operating conditions?

32. Are there any tests to show the effect of shock when engines are direct-connected to equipment that may hit an immovable object?

33. At what speed and load may the greatest efficiency be expected? Can this be picked off the performance curves?

34. Is it any more important that an air-cooled engine, that has operated under heavy load, be cooled gradually (idled) than a water-cooled engine?

35. What happens if it is shut off while still excessively hot?

36. Would a tune-up guide be practical?

37. Is too much crank case oil harmful? Why?

38. Should condensers be replaced along with points? Without first testing the old condenser?

39. What is meant by corrected torque and horsepower?

40. Do you agree that <u>dirty oil</u> and <u>incorrect timing</u> are the primary causes of premature engine failure?

41. Describe the three basic spark plug conditions that reveal whether the engine is running too hot, too cold, or just right.

42. What are the ill effects of running an engine with <u>too lean</u> a fuel mixture? Too rich?

APPENDIX B

EVALUATION OF PRELIMINARY DRAFT
(Questionnaire to Teachers)

Evaluation from Classroom Instruction and Laboratory Exercises
of the Preliminary Draft of
"SMALL ENGINES - CARE, OPERATION, MAINTENANCE AND REPAIR"

Date _____

I. Name _____

II. Address _____

_____

Teacher Background

1. Number of years teaching vocational agriculture (check one):

5 or less _____, 5 - 10 _____, 10 - 15 _____, 15 or more _____.

2. Training received in small engines:

High school: Vocational agriculture _____ weeks.
Industrial arts _____ weeks.
Trade school _____ weeks.

College: Name of course _____.
Duration _____ weeks.

In-service short courses: Number of courses _____.
Total time spent in all courses _____.

3. Number of years teaching small gasoline engines in high school (check one):

0 ____, 1 ____, 2 ____, 3 ____, 4 ____, 5 or more ____.

4. Number of short courses taught on small engines to young and adult farmers:

0 ____, 1 ____, 2 ____, 3 ____, 4 ____, 5 ____, more than 5 _____.

5. Practical experience in the care and repair of all types of engines:

Total time ____ months.

Types of engines: small ____, automotive _____, other _____.

Types of experience: care and operation _____, maintenance and repair _____.

Was the experience on your engine(s)? _____.

Was the experience on engines belonging to the public? _____.

Information Regarding the Book

1. What subject did you teach from this preliminary draft?

_____

(If you taught more than one subject, complete a questionnaire for each subject taught.)

2. How many students were in this class? _____

3. Have your students had texts or reference materials in the past?

   Yes _____ No _____.

   If yes, how many? _____

   What was the name of the references? _____

   _____

4. Did you make study assignments to the students? Yes _____ No _____

   (Check one)

   Home work _____

   Class work _____

5. Did you change your teaching procedure while using this book?

   Yes _____ No _____

   Explain _____

   _____

6. Were you previously familiar with the subject before obtaining this book?

   Thoroughly _____, Somewhat _____, Not at all _____.

7. Did you use any additional reference material in the preparation of your lesson plan? Yes _____. No _____.

   If yes, name other references used and state why._____

   _____

   _____

   _____

8. Did you change the organization of the material to fit your lesson plan outline?

   Yes _____, No _____.

   If yes, what changes were made? _____

   _____

   _____

   _____

9. Were the explanations of principles easy to understand? Yes _____, No _____.

   If not, state what difficulties you had. _____

   _____

   _____

   _____

   _____

10. Was enough information given on the subject to explain all points fully?

    Yes _____. No _____.

    If not, what was lacking? _____

    _____

    _____

    _____

    _____

11. Was too much information given on the subject? Yes _____, No _____.

    If yes, what should be left out? _____

    _____

    _____

12. Did you find any errors or misstatements of fact in the subject matter?

    Yes _____. No _____.

    If yes, what were they? _____

    _____

    _____

    _____

13. Were there sufficient illustrations? Yes _____, No _____.

    If not, suggest additional illustrations. _____

    _____

    _____

If yes, which ones should be deleted? _____

_____

_____

Explain why. _____

_____

_____

14. Did the illustrations add clarity to the discussion? Yes _____. No _____.

    How much? 5% ____, 10% ____, 15% ____, 20% ____, 25% _____, more _____.

15. Were all of the illustrations clear and understandable? Yes _____. No _____.

    Which ones were not? _____

    _____

    What changes would you suggest in the illustrations to improve them?

    _____

    _____

    _____

16. What were the outstanding features about the illustrations? _____

    _____

    _____

    _____

17. Did you have difficulty finding the illustrations which were referred to in the text? Yes _____. No _____.

    If yes, what suggestions do you have for improving this situation? _____

    _____

    _____

18. Was the tools and materials list adequate? Yes _____. No _____.

    If not, what other tools were needed? _____

    _____

19. Did the students understand the principles from reading the book without additional information? Yes _____. No _____.

If not, what did you have to explain? _____

_____

_____

_____

20. Were the students able to complete their job without assistance when following the step-by-step procedures in the book? Yes _____. No _____.

If not, what assistance did they need? _____

_____

_____

_____

21. What questions were asked by the students as you taught this subject?

_____

_____

_____

_____

22. Were you able to prepare your lesson plan faster or slower by the use of this book? Faster _____ Slower _____.

How much? 5% _____, 10% _____, 15% _____, 20% _____, 25% _____, more _____.

23. In your opinion, did your students learn faster or slower from this book than previous students whom you have taught without it?

Faster _____ Slower _____

How much? 5% _____, 10% _____, 15% _____, 25% _____, more _____.

24. Was the average grades for this class higher or lower than the grades in previous classes?

Higher _____ Lower _____

How much? 5% _____, 10% _____, 15% _____, 20% _____, 25% _____, more _____.

General Questions About the Book

1. Would a filmstrip developed to be used parallel to this book be helpful?

   Yes _____. No _____.

2. Would a set of overhead transparencies developed to be used parallel to this book be helpful?

   Yes _____. No _____.

3. Suggest ways you think the book can be improved in its final form?

   _____

   _____

   _____

   _____

4. Do you think color will add to the learning effectiveness of the book?

   Yes _____. No _____.

   If yes, how much? 5% _____, 10% _____, 15% _____, 20% _____, 25% _____, more _____.

5. Due to the size of the book, do you prefer that it be issued in two volumes, _____ or one volume _____?

6. For effective teaching do you think every student should have a copy of the textbook while studying small engines? Yes _____. No _____.

   If yes, why? _____

   _____

   If no, why? _____

   _____

7. General comments. _____

   _____

   _____

   _____

   _____

   _____.

Student Background

1. Class taught:

   1st year ag. _____, 2nd year ag._____, 3rd year ag. _____, 4th year ag ____,

   Adult ____, other _____.

2. Average age of students in the class: (check one)

   10 - 12 years ____, 12 - 14 years _____, 14 - 16 years ____,

   16 - 18 years ____, other ____.

3. Had the class had previous training in small engines?

   Yes ____. No _____.

   If yes, what type and amount?

   Theory _____ length of time _____.

   Practical _____ length of time _____.

   Both _____ length of time _____.

APPENDIX C

WHAT OTHERS SAY
(Excerpts from Letters)

C. What Others Say

The following are excerpts from letters received from reviewers of the preliminary draft of the small engines publication and from recipients of the final published draft.

> It appears to be well organized, very complete, and certainly will be a help to the small engine mechanic.
>
> A. G. Kroos, Jr., Sales Manager
> Engine Division, Kohler Company
> Kohler, Wisconsin

> This is the most wonderful thing that I have ever seen. Everything certainly looks good and I hope that we can use this book next fall.
>
> J. E. Sheffield, Vo. Ag. Teacher
> East Biscoe, North Carolina

> Our compliments to you in making such a book on small engines -- it appears to be an excellent compilation of material and we feel honored in having a small part in its make up.
>
> L. Whitney, Service Engineer
> Sealed Power Corporation
> Muskegon, Michigan

> We have received your proposed publication and it looks very good to us, though we do not feel qualified to criticize it from a technical point of view. We also submitted it to our engineer for products using this type of engine. Due to the pressure of other work, he was not able to review it in detail, but he commented after several days study that it looks so good, he would like a copy for reference purposes when it is published.
>
> So it appears you have done a commendable piece of work.
>
> Leslie I. Malmloff, Engineering
> Products Publication Supervisor
> International Harvester Company

Thank you for the opportunity to review the preliminary draft of the small engines text. I am very much impressed with the overall content and emphasis in this text and believe it will make a real contribution to our instructional needs.

Clint O. Jacobs, Assoc. Prof.
Agricultural Mechanization
Texas A & I University
Kingsville, Texas

It is basically a good manual that is simple enough to be understood, yet presents the principles of operation that will make it possible for the operator to solve some of the peculiar problems that cannot be covered in any manual.

D. L. Donovan, Asst. Chief Engineer
Tillotson Manufacturing Company
Toledo, Ohio

In general the comments received from our personnel were very favorable. They felt the information provided would be helpful for the student or beginning small engine repair technician.

Jack Carroll, Service Manager
McCulloch Corporation
Los Angeles, California

I have briefly reviewed your publication and feel that you have more than adequately covered the small engine field. In fact, I would recommend that if at all possible the manual be reviewed from the point of view of deleting copy to make it more usable from a student's standpoint.

Charles C. Eddie, Supervisor
Training and Publications
Tractor and Implement Operations (U.S.)
Ford Motor Company
Birmingham, Michigan

I think this is an excellent manual that you have prepared and will certainly fill a demanding need in all walks of life. There is hardly a homeowner today who does not have some type of small gasoline engine and needs to have additional information that would not be found in the manufacturer's instruction book. This manual should precipitate workshops and special conferences for vocational agriculture teachers in getting them better prepared for handling the ever increasing problems facing them with small engines. We have been looking forward to this publication with anticipation and are certainly highly pleased that it is about to be published in the final form. It is going to be an excellent publication and should be in demand by a widely varied group of people

J. J. McDow, Head, Dept. of Ag. Eng.
University of Tennessee
Knoxville, Tennessee

I would compliment you upon the fine job that you have done with this publication. I feel that this will be a very useful publication for teachers of vocational agriculture to use in their agricultural mechanics program.

Kenneth K. Mitchell
State Supervisor
Agriculture Education
Tennessee

We were very much impressed with the fine job your staff did with these books, and are pleased to have had the opportunity to have assisted with them. They will make welcome additions to my library.

R. F. Meeker
Editor
Magazine Lubrication
Texaco

Those of our staff who have had an opportunity to look at it are very pleased with the final results. The material, color, layout, is excellent. The content of materials is excellent too.

Philip E. Schmidt
Organization & Youth Specialist
Farm Department
National Safety Council

This is certainly a very attractive publication and one that appears to be set up in such a manner that it would be easy to utilize in a classroom situation.

Orlin D. Bakken
Director of Continuing Education
N. Dakota State School of Science

These volumes are extremely well done and should be of great benefit in the training of service personnel.

Richard Bayley
Service Administrative Assistant
Evinrude Motors

Your simplified description of diode and transister action is just what we need to explain this in elementary courses.

Earl R. Young
Associate Professor
Agricultural Engineering
University of Kentucky